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AUTHOR Streumer, Jan N.; Doornekamp, B. Gerard
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ABSTRACT

The Technology Assessment Study was aimed at describing the achievement of 14- and 15-year-old Dutch students who either did or did not take a course on technology. The objectives for the subject of technology in the Netherlands are discussed, as stated in the revised Curriculum Guideline for Technology of the Foundation for Curricular Development. Student achievement was assessed primarily by means of a written test (the Technology Achievement Test) developed by the project team. This test was administered to 1,805 students from 86 schools representing various types of secondary education. A total of 773 students took the technology course, whereas 1,032 students did not. In addition, a school questionnaire and a pupil questionnaire were developed and used. For students who participated in the technology course, the highest mean total score was achieved by those attending schools for junior technical training. The next highest mean total score was achieved by those attending schools for junior agricultural training and middle schools. In general, study results indicate that male students' mean total score is significantly higher than that of female students. Furthermore, there does not appear to be a relationship between father's level of education or father's profession and a student's test scores. (Author/TJH)

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THE NEED FOR TECHNOLOGY EDUCATION

Some results of the Technology Assessment Study in the Netherlands

Jan N. Streumer, B. Gerard Doornekamp
University of Twente
Department of Education
Division of Curriculum Technology
and Educational Administration
P.O. Box 217
7500 AE Enschede
The Netherlands

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ABSTRACT

The Technology Assessment Study was aimed at describing the achievement of 14/15-year-old pupils who either did or did not take Technology, with reference to the objectives for the subject Technology, as stated in the (revised) Curriculum Guideline for Technology of the Foundation for Curriculum Development (SLO). The pupils' achievement has been, among other things, assessed by means of a written test (the Technology Achievement Test) which has been developed by the project team. This test was administered to 1805 pupils in 86 schools (various types of secondary education).

For the condition "Technology" the highest mean total score belongs to pupils of schools for junior technical training, immediately followed by pupils of schools for junior agricultural training and middle schools. This study shows that the boys' mean total score is significantly higher than that of the girls. Furthermore it becomes evident that no relationship exists between either father's level of education or profession and childrens' test scores.

INTRODUCTION AND PROBLEM STATEMENT

Following on the Technology Entering Behaviour Study (Streumer & Doornekamp, 1986) the Division of Curriculum Technology of the Department of Education of the University of Twente started a further study within the field of Technology: the 'Technology Assessment Study' (Streumer, 1987).

It is the object of this study to assess the achievement of 14/15-year-old pupils with reference to the objectives for the subject Technology, as stated in the (revised) Curriculum Guideline for Technology of the Foundation for Curriculum Development (SLO), after two years of secondary education. As far as the pupils' knowledge and skills are concerned their achievement is assessed by means of a written and a practical test, and as far as their attitude is concerned, the pupils' achievement is assessed by means of a pupils' questionnaire.

In this article the term 'assessment', after Davis, Alexander & Yelon (1974, p. 81), is defined as '... a continuous process of collecting and interpreting information in order to assess decisions made in designing a learning system.' Herewith it has to be noted that the data-gathering is large-scale in character. By measurment we understand it as the method to make an accurate assessment of the extent of 'achievement'. Tests refer to the use of instruments to measure 'achievement'. So measurments and tests are ways to gather evaluation- and assessment-data. The approach to measurment we chose is essentially one of measuring in a criterion-oriented way; this means that the scores of the tests are interpreted in an absolute sense. Van der Linden and Pelgrum (1982) pose that it applies to tests that are to be used in assessment-research that such tests have to guarantee a good coverage of the curriculum of the subject in question. Here it concerns the issue of content validity; we shall go into this in the section on 'Instruments'.

In this article only the test results gathered by means of the written test (the Technology Achievement Test) are reported (the results of the practical test are reported in Doornekamp, 1987). The test does not only contain 'knowledge questions', but also questions measuring the cognitive conditions that must be met by the pupils in order to be able to carry out certain practical skills (such as cutting, bending, drilling, sawing, filing, soldering), the so-called "performance based

test items" (Directorate US Army Support Center, 1977).
The differences in achievement between pupils of both subpopulations ('Technology' or 'no Technology') will be accounted for on the basis of school factors and individual pupil factors.

Technology in the Dutch Educational System

The formal educational system comprises three levels: primary education (including kindergarten); secondary education and higher education (vocational colleges and universities). Secondary education was fully restructured by the 1968 Secondary Education Act, called the Mammoth Act. Since then secondary education comprises four main types of schools, pre-university education, including pre-university schools; gymnasia and athenea (length of the course six years); junior and senior secondary education (length of the course four and five years respectively); junior and senior secondary vocational education (length of the course four years); miscellaneous types of secondary education - part-time or full-time - such as apprenticeship system.
In junior secondary vocational education, courses are provided, mainly at separate schools, in the following: technical subjects (junior technical schools); home economics (junior domestic science schools); agriculture (junior agricultural schools); commercial studies (junior economic and administrative schools); and retail trade and nautical subjects.
In 1988 secondary education is still predominantly (organized) vertically, based on the assumption that 12-year-old pupils can be selected into different types of schools on the basis of their scholastic aptitude. The selective school system has been under discussion and at the beginning of the 1980s studies and experiments have been undertaken about the desirability of having a three-year comprehensive school intended for all children (i.e. children in the age-bracket from 12 to 15).
In the Netherlands extensive use is made of the possibility of organizing education on the basis of one's own outlook on life. Whereas in 1900 59 percent of the children attended public schools and 31 percent attended private schools; by the 1960s this had become 27 and 73 percent respectively and in 1980 the figures were 32 and 68 percent. This change may be linked to the desegregregation movement which started

in the 1960s and led to the break-down of the denominational structure in various fields, expecially among the Catholics and to a smaller extent among the Protestants. However, in education denominational desegregation practically failed to materialize.

In 1973 the subject Technology was introduced in the first two grades of junior secondary vocational education by a government resolution. In comprehensive school reforms Technology was also one of the subjects to be taught. In 1978 the Foundation for Curriculum Development (SLO) was ordered by the Ministry of Education and Sciences to make recommendations for the content and organization of the subject Technology. There happened to be much diversity of opinion about this new subject, so a committee consisting of twenty representatives from various groups (teachers, school boards, parents, etc.) was appointed to develop a Curriculum Guideline (in concept). In December 1981 the SLO presented the definite Curriculum Guideline to the Ministry of Education and Sciences for approval and this was accepted. Schools introducing Technology are now tied to the Curriculum Guideline of the SLO. The Curriculum Guideline consists of many aims, divided into five complementary sets:

a. to teach pupils knowledge of and insight into phenomena (including social phenomena) based on the so-called pillars of technology: matter, energy and information;
b. to offer pupils the opportunity to develop technical thinking skills;
c. to teach pupils to combine technical skills, knowledge and insights, being able to function independently in an environment dominated by technical phenomena;
d. to develop a positively critical attitude towards the possibilities and means of technical progress; and
e. to deal with technical products in a responsible way.

Since 1984 Technology may be introduced as an experimental subject into other types of secondary education, such as junior and senior secondary schools, and all types of pre-university education (first two grades).

In 1985 the Ministry of Education and Sciences established the Technology Study Group. This Study Group was given the assignment to generate new core contents for the subject of Technology in view of the introduction of Technology in the complete system of secondary education. On the basis of the Report of the Technology Study Group

(Technology Study Group, 1986) the Ministry of Education and Sciences in January 1986 gave to the SLO the assignment to design a new Curriculum Guideline for Technology.

From this chronological review it becomes evident that changes in policy with reference to Technology came about with considerable speed. In carrying through rapid changes in policy and consequent revisions of curricula, research-data such as that presented here are published sometimes after the changes have occurred. This is somewhat frustrating for the work of researchers aiming to guide policy.

DESIGN OF THE RESEARCH

Research Populations

The research population concerns 14/15-year-old pupils in the third year of secondary education. There are no figures available concerning either the number of pupils taking Technology courses or the number of schools spread over the types of schools where Technology comes up on the timetable. It was decided to take a stratified sample from a recent file of schools for secondary education which was chosen from a selection of intact classes in two steps: first schools were selected randomly, and secondly from each of these schools one class from the third year(grade) was chosen. In compliance with the statistical demands the number of intact classes was put at 77 and the number of partaking pupils at 1836. In three rounds 255 schools for secondary education had been invited to participate. The total number of schools for secondary education that reacted was 169, and 86 of those reactions were positive (Table I).

Table I: Respons and non-response (n=255).

response		non-response
169 (66.3%)		86 (33.7%)
positive	negative	
86 (50.9%)	83 (49.1%)	

On the basis of data, that were provided by the schools by means of an information form, the cooperating schools were divided into two groups: 'Technology' (37 schools) and 'no Technology' (49 schools).
The sample does not comprise schools for secondary general education, with an exception for junior secondary schools, where Technology is on the timetable. This is not surprising because Technology has hardly been introduced in these types of secondary schools. In all other types of schools for secondary education (including comprehensive schools) Technology is on the timetable. According to those educationists knowledgeable about schools this division of schools within our sample provides a representative one of "technology" versus "non-technology schools". The final sample consists of 86 intact classes with 1805 pupils. In Table II the pupils are classified according to the type of school.

Table II: Number of pupils for each type of school for secondary education.

Type of secondary education	Technology	No technology	Total
pre-univesity school	-	79	79
athenea	-	49	49
gymnasia	-	71	71
senior secondary school	-	124	124
junior secondary school	78	570	648
junior technical school	313	-	313
junior economic and administrative school	70	74	144
junior agricultural school	88	-	88
junior domestic science school	183	65	248
middle school	41	-	41
Total	773	1032	1805

Instruments

The achievement of all pupils of the research sample with reference to Technology has been assessed by means of the Technology Achievement Test. An explanation of the differences in achievement may be based on school factors (Technology/no Technology on the timetable, the number of

hours available for Technology, the training of Technology-teachers, use of the Curriculum Guideline for Technology of the SLO, availability and use of equipment, the stage of introduction of Technology, etc.) and individual pupil factors (sex, hobbies, education and profession of parents, etc.). To gain insight into these variables a school questionnaire and a pupils' questionnaire have been developed.

a. Technology Achievement Test.

In the construction of the Technology Achievement Test the following curricular question was apparant to the researchers: what is the content of the subject? Goodlad et al (1979) distinguish five types of curricular, namely 'ideological', 'formal', 'perceived', 'operational' and 'experiental'. What is important in this research is the distinction between 'formal curricula', which concerns curricula in the form of documents that have a status of being more of less officially approved or sanctioned and 'perceived curricula', which concerns perceptions of teachers with reference to curricula.

Although the Ministry of Education and Sciences declared in 1984 that the Curriculum Guideline for Technology of the SLO had to be the official guideline for the introduction of Technology in secondary education, the schools in the Dutch system of education are autonomous to such an extent that one may expect this 'formal curriculum guideline' to be actually interpreted in completely different ways (perceived curriculum).

Since there was no file-record of the form and content of the perceived curriculum at the beginning of this research project, the construction of the Technology Achievement Test was started from the aims as stated in the Curriculum Guideline for Technology. The aims are divided into three categories: I. Thinking and acting in a technical way, in the sense of **working on and processing materials** such as: knowing properties and applications of materials -solid, liquid, gas-; selecting materials; knowing principles of devices -hydraulic, pneumatic, mechanical, electrical, etc. ; using tools, instruments and equipment; using construction principles, moulding materials. II. Thinking and acting in a technical way, in the sense of dealing with **products of technology** such as: using energy consuming devices; designing action, project, prototype or product; using algorithms and heuristics; applying safety instructions and III. Introductions to **technical phenomena in society**

such as: knowing important technical events -on timeline-; knowing impacts of technologies -nuclear power, acid rain, malnurition, over-production, exhaustion of resources etc.-; developing a flexible attitude towards the rapid evolution of technology.

As these aims had been formulated at such a general level a conversion had to be carried out in three stages:

Stage 1: formulation of objectives to match the objectives of the Curriculum Guideline for Technology;

Stage 2: evaluation of the objectives for several aspects (consistency, level, completeness, etc.) by relevant respondents (curriculum experts and content experts) at a curriculum conference;

Stage 3: decision on the final formulation of the objectives.

The objectives, 150 in all, have been included in the Technology Aims Catalogue.

In first instance the construction of the test items has been carried out by the project group of the University of Twente. The experimental version of the written test (150 items) has been evaluated by both curriculum and content experts and by psychometricians. The experimental version has also been tested with a total number of 206 pupils from ten classes, spread over secondary education.

After revision, the remaining test items (142 in all) were randomly divided for each category over five subtests. Since the scores of individual pupils were not important, and attention was being focused on the effects of education in Technology, it was not necessary for all pupils to answer all the questions of the test.

It is therefore possible to use the 'multiple matrix sampling' design ('M.M.S.' design). In this design the test items are presented to a 'sample of pupils', taken from all pupils (n=1805) that qualified for the research. At this point no distinction was made yet between pupils from "technology" and "non-technology schools". It is also possible to take a sample of all the test items and present it to all qualifying pupils (test-item sample). A combination of these two samples result in a pupil/test-item sample: one group of pupils answers part of the test items ('matrix sampling'). In the test more than one matrix-sample is used ('multiple matrix sampling'). By using this procedure it is possible to guarantee that the objectives are fully covered by the test items on the one hand, whereas on the other hand the partaking pupils

need to answer only part of the test items.

On the basis of the answer scores, obtained by means of the 'M.M.S.'-design, it is possible to make an estimation of, among other things, the mean, standard deviation and reliability of the test (Shoemaker, 1973).

b. School Questionnaire.

There are **two** versions of the school questionnaire: one for schools with Technology (version A) and one for schools without Technology (version B). Both questionnaires consist of a general part and a specific part.

The specific part of the "technology" school questionnaire (A) contains questions about: the number of hours for Technology courses, the use of the Curriculum Guideline for Technology, the training of Technology teachers, the methods, course material and equipment that is used for Technology. On the basis of the available information the schools have been divided into profile-groups. Because of the large variance in the information with reference to the relevant variable it appeared to be very difficult to make a division into three profiles. We opted for a division based on the following variables: number of hours for Technology on the timetable in the second grade and the presence of a special Technology-laboratory. This results in the following three profiles:

profile A1 : schools with less than four hours of Technology in the second grade;

profile A2 : schools with four or more hours of Technology in the second grade **and** the presence of one or more Technology laboratories;

profile A3 : schools with four or more hours of Technology in the second grade **and** no special Technology laboratory.

The specific part of the "non-technology" school questionnaire (B) contains questions about: the organization of subjects that are related to Technology, plans and equipment in view of the possible introduction of Technology.

The division of these schools into profiles is based on the first three levels of use, as distinguished by Loucks (1977). The available information results in the following three profiles:

profile B1 : no orientation towards Technology;

profile B2 : orientation towards Technology;

profile B3 : preparation for the introduction of Technology.

c. Pupils' Questionnaire.

The pupils' questionnaire consists of two parts. Part A refers to information about the pupil (age, sex, school record, hobbies, etc.), information about the parents (education, profession, etc.), the family's cultural background and the presence of hobby equipment at home. Part B contains an attitude questionnaire which will not be discussed any further in this article.

RESULTS

Introduction

As stated the 'multiple matrix sampling'-design was used. The five subtests were completed by equally large groups of pupils. The estimated mean score of the entire sample for the entire test is 70.12. The reliability of the entire test is estimated at 0.88. The required calculations have been carried out by means of a (revised) computer program by Shoemaker (1973).

In the presentation of the results the five subtests are considered to be identical, they were brought about on the same basis. This makes it possible to use programs from the available SPSS- and SPSS-X-programs. A distinction is made between two conditions, viz. 'Technology' and 'no Technology'. For each condition the mean total scores and the mean scores of the three categories, into which the objectives of the Curriculum Guideline for Technology have been divided are presented.

The Type of Secondary Education and the Test Scores

Also on the basis of the "Study of the Entering Behaviour for Technology" (Streumer & Doornekamp, 1986) it is expected that the "higher" (more academic) the type of secondary education attended by the pupil, the higher the mean total score will be (pre-university education is considered to be the "highest"). It may also be expected that if pupils have had Technology courses they will have a positive influence on the mean total score on achievement.

In Table III the mean total scores and the scores per category on the Technology Achievement Test are presented for each type of secondary education. The empty cells, under the condition 'Technology', refer to

the fact that in the school types in question no Technology is taught; the empty cells under the condition 'no Technology' indicate that at all schools for junior technical training, junior agricultural training and middle schools Technology is taught.

Table III: Type of secondary education and mean scores for each category (I, II or III) of the Technology Achievement Test.

Type of secondary education	Technology				No Technology			
	I	II	III	total	I	II	III	total
pre-university school	-	-	-	-	5.62	5.19	5.32	16.20
athenea	-	-	-	-	5.62	4.90	5.29	15.86
gymnasia	-	-	-	-	5.41	5.11	4.94	15.51
senior secondary school	-	-	-	-	5.30	4.96	4.82	15.15
junior secondary school	5.58	4.40	4.14	14.13	5.09	4.38	4.16	13.68
junior technical school	5.83	5.27	4.34	15.23	-	-	-	-
junior econ. and adm. school	4.56	3.34	3.54	11.99	4.82	3.49	3.59	11.95
junior agricultural school	5.86	4.90	4.22	15.05	-	-	-	-
junior domestic science school	4.81	3.42	3.30	11.57	4.97	3.11	3.06	11.17
middle school	5.93	4.78	4.34	15.10	-	-	-	-
Total	5.48	4.54	3.99	14.05	5.18	4.44	4.33	14.00

For the condition 'Technology' the highest mean total score belongs to the pupils of junior technical schools, immediately followed by pupils of junior agricultural schools and middle schools. What strikes the attention is the low mean total score of pupils of junior economic and administrative schools and junior domestic schools.

For the pupils who did not take Technology it may be observed that as the type of secondary education gets higher (more academic), the mean total score also gets higher. It is plausible that this is related to certain characteristics of pupils, such as their general level of knowledge and intelligence.

For junior technical schools, junior agricultural schools and middle schools it is not possible to draw a comparison between pupils who did or did not take Technology, since there were no respondents in the condition "no Technology". The mean total scores of pupils of junior technical schools, junior agricultural schools and middle schools are more or less equal to scores of pupils of gymnasia and senior secondary schools. Here it must be noted that the last mentioned group did not take Technology. The high mean total scores of the pupils of senior secondary schools and gymnasia are possibly caused by high scores on test items that are related to the above mentioned pupil characteristics; the high mean total scores of pupils of junior technical schools, junior agricultural schools and middle schools are caused by high scores on items that appeal to specific technical knowledge. This is confirmed by the mean scores per category in Table III: the mean scores of pupils (in category I) of junior technical schools, junior agricultural schools and middle schools are in each and every case higher than the mean scores of pupils of senior secondary schools, gymnasia, athenea and pre-university schools in category I; the mean scores of the last mentioned groups of pupils in category III are in all cases higher than the scores of pupils of junior technical schools, junior agricultural schools and middle schools.

The Pupil's Sex and Test Scores

In the Curriculum Guideline for Technology it is indicated that Technology should attempt to neutralize the traditional male-female role-cast. Differences in achievement based on sex, therefore, should no longer occur. If education in Technology could fully realize this, it may be expected that the mean scores for girls will hardly differ from those for boys, whereas scores for those who did not take Technology courses will still differ.

In Table IV the results of a number of T-tests are presented, carried out on the mean total scores, whereby a distinction has been made between pupils taking and not taking Technology courses.

Table IV: Pupil's sex, school-type and mean scores on the Technology Achievement Test

		Technology			No Technology		
Type of school	sex	n	mean score	T-test	n	mean score	T-test
pre-university	b	-	-		44	17.02	
school	g	-	-	-	34	15.18	2.39*
athena	b	-	-		17	17.82	
	g	-	-	-	31	14.74	2.95*
grammar school	b	-	-		32	15.97	
	g	-	-	-	39	15.31	1.18
senior secondary	b	-	-		60	16.37	
school	g	-	-	-	64	14.02	3.96*
junior secondary	b	33	15.45		250	14.89	
school	g	45	13.16	2.78*	317	12.71	6.92*
junior technical	b	306	13.59		-	-	
school	g	7	13.00	-	-	-	-
jun.econ. and	b	22	12.45		26	13.27	
admin. school	g	48	11.77	0.73	48	11.23	2.61*
jun. agricultural	b	68	15.35		-	-	
school	g	20	14.00	1.70	-	-	
jun. domest.	b	2	18.00		-	-	
science school	g	181	11.50	-	65	11.17	-
middle school	b	18	17.28		-	-	
	g	23	13.39	3.25*	-	-	-
Total	b	449	15.47		429	15.41	
	g	324	12.09	15.47*	598	12.96	10.50*

* = significant, alpha 0.05, two-sided

It is observed that, for the condition of 'no Technology', the boys' mean total score is significantly higher than that of the girls as far as pre-university schools, athenea, senior secondary, junior secondary and junior economic and administrative schools are concerned. For the condition 'Technology' significant differences in the scores are found in favour of boys at junior secondary and middle schools. The T-tests for the junior technical and junior domestic science schools have not been carried out for this condition, because girls are under-represented at junior technical schools and boys at junior domestic science schools. The data in the column 'Technology' are extremely disappointing in view of one of the tasks the subject Technology set for itself, viz. to remove the existing differences between boys and girls with respect to

technology.

Father's Profession and Education and the Pupils' Test Scores

Differences in test scores may be related to the parents' profession and education. Within the framework of this research study an index for socioeconomic status was not used, but the father's level of education and his profession, conformed to the Professional Classification of the Dutch Central Bureau for Statistics (CBS, 1984). It is expected that pupils, whose fathers have a technical profession (category 'professions in crafts, industry, transport and functions related to this'), will on the whole have a higher score than pupils whose fathers have a non-technical profession. Mean scores were found that did not differ much for each of the two categories of professions. Pupils whose fathers had a technical profession did not score higher than other pupils.

The father's education (classified in 'primary education', 'secondary education' or 'tertiary education') did not relate to the test scores either. Increase in the level of education did not link up with an increase in the total score (for both conditions). Regardless of the fact of wether or not the fathers had a low or a high education, the scores of the pupils ranged from low to high.

The Schools for Secondary Education and Test Scores

a. Schools with Technology courses.

Schools at which Technology courses are given can be classified in two ways: 1. a classification according to profile (see section on 'Instruments') and 2. a classification according to the grade(s) in which Technology is given.

Concerning the classification according to profile, table V gives for each profile the mean total scores and the scores per category.

Table V: Profile of schools for secondary education and mean scores for each category (I, II or III) of the Technology Achievement Test

profile	Technology (A)				No Technology (B)			
	I	II	III	total	I	II	III	total
1	5.30	4.23	3.87	13.50	5.13	4.53	4.44	14.16
2	5.51	4.66	3.95	14.17	5.32	4.73	4.53	14.63
3	5.86	4.93	4.44	15.28	5.09	3.95	3.95	12.91

* the profiles refer to A1, A2 and A3 of "technology" schools and to B1, B2 and B3 of "non technology" schools as indicated in the text.

The three profiles for the condition 'Technology' are not different from one another in the sense that profile A2 is closer to the formal curriculum-profile for Technology than profile A1. The same applies to profile A3 in relation to A2. With this condition the pupils from profile-group A3 score highest (both the mean total score and the mean scores per category). Almost 80% of the pupils of schools with profile A3 are from junior technical schools and middle schools. The junior technical schools are the ones with the longest tradition of Technology education. It is true that at the greater part of these schools there is no, or only one, special Technology-laboratory, but on the other hand, these schools do have classrooms with traditional and modern technological tools, machines and devices, equiped for other subjects than Technology. In the other profile groups pupils from schools for junior secondary, junior economic and administrative and junior domestic science training are more amply represented.

In some secondary schools technology is **only** taught for one year **either** in the first or second grade. Most schools have Technology on the timetable both in the first and in the second grade. In Table VI a survey is given of the mean test scores for the three possibilities mentioned above as to the grade in which pupils are exposed to technology.

Table VI: Mean test scores of third-grade pupils for each category of the Technology Achievement Test, who have **only** been taught technology in first grade or in second grade or in both first and second grades.

Grade(s)	Technology			
	I	II	III	Total
first	4.79	3.92	3.18	11.97
second	5.66	4.96	4.31	14.97
first + second	5.44	4.39	3.90	13.78

On the whole, pupils of schools at which Technology is given only in the second grade score higher than pupils at which Technology is given either in the first grade only, or both in the first and in the second grade. Schools at which Technology is given 'only in the second grade' are mostly junior technical schools and at these schools there are sometimes even as much as 13 hours on the timetable reserved for Technology. In this case time has a much greater impact on the pupils' scores than the grade in which Technology is given.

b. Schools without Technology courses.

Table V presents the mean total scores and the scores per category for each profile group (condition 'no Technology'). The pupils of schools within the categories 'no orientation' and 'orientation' (profiles B1 and B2) score higher than pupils of the schools that have already reached a level of 'preparation' (profile B3). With these profiles there is a case for suggesting a growing degree of orientation towards Technology. Here too attention must be paid to the make-up of the profile-groups. Profile-group B3 mostly consists of schools for junior domestic science and junior economic and administrative training. The profile groups B1 and B2 are made up of secondary general schools. Above, we already discussed the differences for each type of school and noted that there were low scores for pupils of junior domestic science schools and for junior economic and administrative schools. Thus the make-up of the three profile groups also affects the mean total score. The low mean score of profile group B3 is explained by the over-

representation of junior domestic science schools and junior economic and administrative schools in this group. That these schools happen to be in the 'preparation stage' is related to the fact that they are often involved in fusions with other types of schools for junior vocational training.

Multiple Regression Analysis

In the previous sections the relationships between the test scores and the various independent variables have been discussed separately. It has not yet been investigated what influence these variables taken together have on the test scores. Variables that seem relevant at first may become less important when they are analyzed in combination with other variables.

To assess the real impact of the various variables we have used the 'New Regression' program (SPSS). We chose a step-by-step method, in which a new factor is taken up in each step. The independent variables considered are: sex, type of secondary education, profile of the school, father's profession, father's level of education. The dependent variable is the total score on the Technology Achievement Test.

In comparison with the study of the "Entering Behaviour for Technology" (Streumer & Doornekamp, 1986) one important variable is missing, viz. the pupil's level of general achievement/intelligence. An additional instrument needed to measure this would have imposed too heavy a burden on the schools. Replacement of this instrument by the pupils' report-marks would have encountered the problem of incomparability. On the basis of data from the study of the "Entering Behaviour for Technology" a strong positive correlation between pupils' levels of general achievement and their scores on the Technology Achievement Test might be expected. Part of the unexplained variance in this multiple regression analysis may be due to these different levels of achievement/ intelligence.

The multiple regression analysis was performed for both conditions: schools with Technology on the timetable and schools without Technology. In the multiple regression analysis, for schools with Technology on the timetable, 39.3% of the variance was accounted for by the factor 'pupil's sex' and 2.2% by the factor 'type of secondary education'. The three other factors (father's education and profession and profile of

the school) had very little influence. Of the variance 57.6% remains unexplained.
In the condition "no Technology" 32.6% of the variance is accounted for by the factor "type of secondary education" and 8.6% by the factor "student's sex". 57.1% of the variance remains unexplained.
The permutation of the variables 'sex' and 'type of secondary education' is related to the fact that the number of types of secondary education is limited in the condition 'Technology' and also to the smaller difference between boys and girls in the condition 'no Technology'.

DISCUSSION

It is a consequence of the design selected for this research that the comparison between 'Technology' and 'no Technology' cannot be carried out within each type of secondary education. This arises from the fact that Technology is not yet taught at most schools for general secondary education and pre-university education, but is very much omnipresent within junior technical and junior agricultural schools.
The mean total scores and scores per category of pupils on the Technology Achievement Test who have not had courses in Technology become higher as the type of secondary education becomes higher (more academic): highest achievement is attained by pupils of pre-university schools; pupils of junior domestic science schools score lowest. In the Study of the Entering Behaviour for Technology (Streumer & Doornekamp, 1986) a positive correlation (0.68) was also found between school achievement test scores and Technology Test scores. If the subscores (per category) of pupils of senior secondary schools and all types of pre-university education ('no Technology') are compared with the subscores of pupils of junior vocational schools, it is striking that only the mean subscores of pupils of junior technical and junior agricultural schools in category I, and the mean subscores of pupils of junior technical schools in category II, exceed the subscores of pupils of senior secondary and all types of pre-university schools. As will be recalled Category I contains items about the working on and the processing of materials while items of category II are about the handling of products of technology. It is not surprising that to be able

to answer particularly the practical items in category I education in Technology is indispensable. This is in contrast to items of category III (introductions to technical phenomena) where levels of intelligence and knowledge of subjects relating to technology play important roles.

The test scores attained by the pupils of schools for junior domestic science training are markedly low. The effect of the Technology education that is given to this group is extremely small. The slight increase in the scores of pupils of junior domestic science schools may be explained on the basis of the following facts: a. the Curriculum Guideline for Technology is focused more on pupils of junior technical and junior agricultural schools than on pupils of junior domestic science schools; b. because of the revision of the Curriculum Guideline for Technology the technical component of the subject matter has been accentuated at the expense of the social component; c. the sample of pupils of junior domestic science schools is made up of girls only, and according to the results of the "Entering Behaviour Test for Technology" these already drop behind whenever the phenomenon technology is concerned, before the subject Technology has even been introduced.

The present study again shows that both the total scores and the scores per category in technology achievement of girls are significantly different from the boys' scores. So the way the subject Technology is taught in schools, that are being investigated at the moment, does not contribute to the removal of performance differences between boys and girls with respect to technology. It cannot be stressed enough that these data will have to be taken very seriously by the Technology Project Group of the SLO and by all Technology teachers.

Furthermore it becomes evident that there is no relationship whatsoever between the father's level of education and the test scores. Also having a father with a technical profession is not related to achievement in technology. Possibly an index of socioeconomic status, in which both the level of profession and the level of education of both parents are taken into account, may lead to different results.

The number of hours of Technology is related to the type of school: four or more hours of Technology are mainly given at junior-technical schools. It is not surprising therefore, that both the mean total score and the mean scores per category in the Technology Achievement Test of pupils from profile-group A3 are highest.

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